BIOLOGICAL EVALUATION
SITE-SPECIFIC CHRONIC NICKEL CRITERION
SANGAMON RIVER, MACON, CHRISTIAN, AND SANGAMON COUNTIES, ILLINOIS

I. Description of Federal Action

Under Section 303 of the Clean Water Act (CWA), states and authorized tribes are required to submit adopted revisions to water quality standards (WQS) to the U.S. Environmental Protection Agency for review and approval. Section 7(a)(2) of the Endangered Species Act (ESA) requires EPA, in consultation with the U.S. Fish and Wildlife Service (FWS), to ensure that any action authorized, funded, or carried out by the Agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely impact habitat for such species. As provided in the Memorandum of Agreement (U.S. Environmental Protection Agency et al. 2001) between EPA and the Services regarding enhanced coordination of CWA and ESA actions, a biological evaluation (BE) is the appropriate type of analysis to determine whether an adopted WQS revision is likely to adversely affect federally-listed species.

On February 21, 2019, EPA received from the Illinois Environmental Protection Agency a rule change package containing a site-specific chronic nickel criterion recently adopted by the Illinois Pollution Control Board for the portion of the Sangamon River from the point at which Outfall 001 of the Sanitary District of Decatur (SDD) discharges to the River to the confluence of the Sangamon River with the South Fork of the Sangamon River. For this portion of the Sangamon River, the adopted site-specific criterion replaces Illinois' statewide chronic nickel criterion.

Compared to Illinois' existing statewide chronic nickel criterion, the site-specific criterion allows for a higher concentration of nickel in the Sangamon River due to the effect of dissolved organic carbon, which reduces the bioavailability of nickel. As described in the supporting documentation provided by Illinois, the site-specific criterion was derived based on paired laboratory toxicity tests conducted by Oregon State University at low and high dissolved organic carbon levels, which indicated lower nickel toxicity at high dissolved organic carbon levels than at low dissolved organic carbon levels. Based on those test results and additional data from the literature, Windward Environmental LLC developed an equation for the relationship between dissolved organic carbon and nickel toxicity and used that equation to adjust Illinois' statewide chronic nickel criterion based on the concentrations of dissolved organic carbon typically found in the Sangamon River. Therefore, at the levels of dissolved organic carbon present in the Sangamon River, the site-specific criterion adopted by Illinois is expected to provide a level of protection of aquatic organisms (including listed species) equivalent to Illinois' statewide chronic nickel criterion, which does not take into account the effect of dissolved organic carbon. EPA has determined that the site-specific criterion is protective of aquatic life in the Sangamon River and intends to approve the site-specific criterion.

II. Action Area

The site-specific criterion will affect the ~45-mile portion of the Sangamon River from the point at which Outfall 001 of the Sanitary District of Decatur (SDD) discharges to the River to the confluence of the Sangamon River with the South Fork of the Sangamon River, in Macon, Christian, and Sangamon counties, Illinois. Illinois' previously-approved nickel WQS remain in effect for all upstream and downstream waters in Illinois.

III. Endangered and Threatened Species Present in the Action Area

In this BE, EPA is required to address all federally-listed endangered and threatened species that may be present in the action area and are designated as either aquatic, aquatic-dependent, or wetland species during any part of their life history.

A. Endangered and Threatened Species and Critical Habitat Potentially in the Action Area

On February 22, 2019, EPA consulted the FWS Midwest Region's Section 7 Consultation website (www.fws.gov/midwest/endangered/section7/s7process/index.html) for a list of endangered and threatened species present in Macon, Christian, and Sangamon Counties, Illinois. EPA found that the following federally-protected species are potentially present: Indiana bat, northern long-eared bat, and eastern prairie fringed orchid. The FWS website lists no critical habitat for the action area. Since eastern prairie fringed orchid is a terrestrial species, EPA's approval of WQS will have no effect on it and EPA did not consider eastern prairie fringed orchid in this BE.

EPA then used FWS's IPaC tool to determine whether protected aquatic, aquatic-dependent, or wetland species might be found within the action area. IPaC indicated that the Indiana bat and the northern long-eared bat are potentially present in the action area.

B. Species Accounts

1. Indiana bat *(Myotis sodalis)*

The Indiana bat was listed as an endangered species on March 11, 1967. Indiana bats are found throughout the eastern United States, where documented declines are primarily due to human disturbance of hibernating bats, modifications to caves in which they overwinter (hibernacula) and natural hazards such as flooding (U.S. Fish and Wildlife Service 2007). Several additional factors are also suspected as contributing to recent population declines, including white-nose syndrome, habitat loss due to changing land use practices (e.g., fire suppression, clearcutting, habitat fragmentation and housing development) and pesticides (U.S. Fish and Wildlife Service 2007, NatureServe 2016).

The total known U.S. population of Indiana bats was estimated to have declined from 679,000 in 1980 to 387,000 in 2003 (NatureServe 2016). In summer, Indiana bats roost in trees and forage for insects in upland and riparian forests (U.S. Fish and Wildlife Service 2007). Habitat associations of the Indiana bat may include small tracts of oak-hickory upland and elm-ash-cottonwood bottomland forest that exist in an agriculturally fragmented landscape (U.S. Fish and Wildlife Service 2007).

Indiana bats feed exclusively on flying terrestrial and emergent aquatic insects. While one study suggested that female Indiana bats in south-central Michigan may tend to favor aquatic insects (Kurta and Whitaker Jr 1998), most studies have consistently shown that Indiana bats feed primarily on terrestrial insects (U.S. Fish and Wildlife Service 2007). For example, Brack and LaVal (1985) studied food habits of Indiana bats inhabiting a cave in Missouri; their data indicated that 84.5% of the male diet and 79.3% of the female diet consisted of Lepidopterans (moths), which are primarily terrestrial. Similarly, Lee and Mc Cracken (2004) studied the food habits of Indiana bats and two other species of *Myotis* in Indiana and found Indiana bats to exhibit a strong preference for Lepidopterans over other insects and to exhibit a much more restrictive diet in this regard than the other two species. Selection of terrestrial insects over aquatic insects is related to the foraging behavior of Indiana bats; Sparks et al. (2005) conducted a study of foraging Indiana bat habitat in Indianapolis and found that the bat preferred woodland to open water as foraging habitat. These results imply that terrestrial prey are a more important food source in the southern part of the bat's range, while aquatic prey are more important in the north (U.S. Fish and Wildlife Service 2007).

2. Northern long-eared bat (*Myotis septentrionalis*)

The northern long-eared bat (*Myotis septentrionalis*) is a medium-sized bat occurring across the eastern and north-central United States. It can be found in 37 states during winter hibernation. There are approximately four million northern long-eared bats within the Midwest, based on 2013 data from Indiana. However, population declines have been observed in Ohio and Illinois and white nose syndrome has been documented in the region.

During winter months, northern long-eared bats hibernate in caves and mines. In the summer, the bats roost opportunistically under the bark of trees or within hollows. Northern long-eared bats are insectivores that use a combination of both hawking (in-flight capture) and gleaning (picking insects off surfaces) to capture prey. The species occasionally forages along riparian areas, but more commonly within forested hillsides or ridges between the understory and the canopy (one to three meters off the ground) (Brack and Whitaker 2001, Lee and Mc Cracken 2004). According to a May 2, 2016 discussion with Phil Delphey, of the Twin Cities FWS office, the northern long-eared bat is clutter-adapted, which means that bats are able to feed in thick forests and do not need to utilize clearings to forage successfully. Additionally, Mr. Delphey indicated that northern long-eared bats rarely stray more than five miles from forested areas when feeding. Therefore, when the northern long-eared bat forages above water, it is generally above small streams and/or pools in densely forested areas.

Studies indicate that the northern long-eared bat feeds primarily on flying insects (Brack and Whitaker 2001), with Lepidopterans (moths) and Coleopterans (beetles) consistently making up 45% or more of their diet (Lee and Mc Cracken 2004, Whitaker 2004, Feldhamer et al. 2009). In addition to beetles and moths, the northern long-eared bat also feeds on a diverse range of other invertebrates, such as Dipterans (flies), Trichopterans (caddisflies), and spiders. The relative contribution of these prey items to the bat's diet varies by location. For example, Trichopterans made up 21.8% of the northern long-eared bat's diet in southern Illinois (Feldhamer et al. 2009), but only 7.1% of the bat's diet in central and northern Indiana (Lee and Mc Cracken 2004). These studies, therefore, indicate that although aquatic insects such as flies and caddisflies may be a significant part of the northern long-eared bat's diet in some locations, terrestrial insects are an overall more important food source to the bat.

The northern long-eared bat was listed as a threatened species on April 2, 2015, largely due to the effects of white nose syndrome on population size. This disease has already decreased the northeastern population by 99 percent and is expected to spread west across the United States (U.S. Fish and Wildlife Service 2015). Other threats to the species are unknown, though they could potentially hasten the bat's decline.

IV. Analysis of Action's Potential to Affect Threatened and Endangered Species

As described in the species profiles in Section III above, the diet, habitat and life history of the Indiana bat and northern long-eared bat are substantially similar. Thus, the potential mechanisms by which approval of Illinois' site-specific chronic nickel criterion could affect either species are the same. Since the Indiana bat and the northern long-eared bat are not aquatic organisms but rely in part on aquatic insects for food, potential effects on both bat species are limited to effects on their aquatic and aquatic-dependent prey, effects on their habitat, and bioaccumulation of nickel.

A. Prey availability

As discussed in Section I above, the adopted site-specific nickel criterion was derived based on the effect of dissolved organic carbon on the bioavailability of nickel. The ameliorating effect of dissolved organic carbon on nickel toxicity has been documented in literature (Hoang et al. 2004, Kozlova et al. 2009) and was verified for this receiving water by paired toxicity tests conducted by Oregon State University. Based on this effect and because the adopted site-specific criterion was calculated based on the dissolved organic carbon concentrations typically found in the Sangamon River, the site-specific nickel criterion will provide the same level of protection for aquatic life in the Sangamon River as Illinois' statewide chronic nickel criterion. As a result, EPA expects its approval will have no effect on the diversity and biomass of emergent aquatic insects that may be consumed by bats near the Sangamon River because the site-specific criterion is expected is expected to protect the community of aquatic insects expected to be present in the Sangamon River. Additionally, because the Indiana bat and northern long-eared bat both consume a mix of terrestrial and aquatic invertebrates and the action area is relatively small, any unanticipated impacts to aquatic invertebrates would have a negligible effect on the overall diet of bats in the area near the Sangamon River. Consequently, , EPA concludes that its approval of the site-specific criterion is unlikely to affect the diet of either the Indiana bat or northern long-eared bat.

B. Habitat

Both Indiana bats and northern long-eared bats hibernate in humid caves with stable temperatures and after hibernation reside in roost trees in wooded areas (U.S. Fish and Wildlife Service 2015, 2017). Neither the Indiana bat nor the northern long-eared bat depends on water quality to meet its habitat requirements. EPA's approval action only affects the allowable nickel concentration in a segment of the Sangamon River and does not affect the presence of humid caves for hibernation or roost trees for summer habitat. Therefore, the Agency determined that its approval of Illinois's site-specific chronic nickel criterion will have no effect on Indiana bat or northern long-eared bat habitat.

C. Bioaccumulation of nickel

While EPA is not aware of any studies that have specifically investigated the potential for bioaccumulation of nickel in bats, studies on other wildlife indicate that the risks to mammals and birds from ingestion of nickel are relatively limited. In mammals and birds, nickel absorption through the gastrointestinal tract is relatively inefficient and mammals appear to be able to eliminate absorbed nickel, primarily through urinary excretion (Outridge and Scheuhammer 1993, Eisler 1998). Based on a review of field studies and controlled laboratory studies, Outridge and Scheuhammer (1993) concluded that mammals and birds can regulate their accumulation of Ni at dietary nickel concentrations up to at least about 100 μg/g dry weight. While aquatic invertebrates may accumulate nickel, tissue concentrations of nickel in aquatic insects are typically less than 25 μg/g dry weight, even in nickel-contaminated environments (e.g., downstream of smelters) (Outridge and Scheuhammer 1993, Eisler 1998). Therefore, wildlife such as the Indiana and northern long-eared bats are generally not expected to accumulate nickel through ingestion of emergent aquatic insects. Additionally, as discussed in Section III.B above, aquatic insects compose only a portion of the overall diets for both Indiana and northern long-eared bats and, therefore, any nickel accumulation in aquatic insects would only affect a portion of the bats' diets.

However, since the studies reviewed by Outridge and Scheuhammer and Eisler did not specifically examine bats and Eisler (1998) concluded that nickel accumulation for wildlife and invertebrates varies significantly by species, EPA searched the primary scientific literature for information on whether Indiana and northern long-eared bats may accumulate nickel to levels that would cause adverse effects. While EPA is not aware of any controlled ingestion studies involving bats, EPA identified three relevant studies that investigated tissue concentrations of nickel in bats near areas of metals contamination. The results of these studies and possible implications for Indiana and northern long-eared bats in the action area are described below. To evaluate the potential effects of the tissue concentrations reported in these studies, EPA relied on general thresholds of 3.0 mg/kg dry weight for liver concentration and 10.0 mg/kg dry weight for kidney concentration identified by Eisler (1998) below which adverse effects to mammals and birds would not be expected. While not based on data specific to bats, these values were derived based on a review of controlled laboratory studies involving several mammals and birds and, thus, account for the range of sensitivity observed in the laboratory.

Ferrante et al. (2018) investigated fur and liver metal concentration in bats (*Myotis myotis*) at a control site and a second site approximately 1 km from an area that has hosted industrial activity since the 1950s. Toxic, persistent, bioaccumulative compounds, including As, Cd, Cr, Hg, Pb, PCBs, and PAHs, have contaminated the latter site, and DNA-, genetic-, and oxidative stress-related impacts have been observed in marine organisms sampled in the area (Ferrante et al. 2018). While the authors reported a significantly higher concentration of nickel in liver tissue in bats from the contaminated site (0.261 ± 0.350 mg/kg, dry weight, vs. 0.129 ± 0.162 mg/kg, dry weight, respectively[1]), they also found that fur from bats taken from the control site had significantly higher nickel concentrations than fur taken from the contaminated site (0.564 ± 0.484 mg/kg dry weight vs. 0.426 ± 0.568 mg/kg dry weight, respectively) (Ferrante et al. 2018). The authors suggest that the higher nickel concentrations in bat fur taken from the uncontaminated control site is indicative of better nutritional status of those bats (Ferrante et al. 2018). All reported liver concentrations of nickel were an order of magnitude less than the threshold (3.0 μg/g) identified by Eisler (1998) for adverse effects.

Mansour et al. (2016) studied metal bioaccumulation in two species of insectivorous bat (*Taphozous perforates* and *Rhinopoma cystops*) inhabiting an agricultural area with waters impacted by improperly treated organic and inorganic wastes and wastewater effluent. Concentrations of these pollutants have been severe enough to cause fish kills and heavy metal concentrations in the impacted waters exceed Egypt's allowable thresholds (Mansour et al. 2016). While the authors found mean nickel concentrations ranging from 0.44 ± 0.01 μg/g to 1.26 ± 0.06 μg/g, dry weight, in *T. perforates* liver samples and from 0.38 ± 0.02 μg/g to 0.90 ± 0.01 μg/g, dry weight, in *R. cystops* liver samples, they were unable to detect nickel in kidney tissue samples from either species. All reported liver concentrations of nickel were at least half the threshold (3.0 μg/g) identified by Eisler (1998) for adverse effects.

Naidoo et al. (2013) studied metal concentrations in kidney, liver and pectoral muscle of bats (*Neoromicia nana*) collected upstream and downstream of wastewater treatment works and at the sludge tanks of the wastewater treatment works. Liver concentrations of nickel at all sites were at or below the detection limit (0.015 μg/g dry weight) and two orders of magnitude below the threshold (3.0 μg/g) identified by Eisler (1998). Kidney concentrations of nickel were below the detection limit (0.015 μg/g dry weight) for 23 of the 26 bats collected and less than the threshold (10.0 μg/g dry weight) identified by Eisler (1998) for all but one of the collected bats. While kidney concentrations of nickel for one bat (19.656 μg/g dry weight) exceeded the threshold for potential adverse effects, that bat had been collected at site where in-stream nickel concentrations were not significantly different from those at the upstream (control) site. Therefore, it is unclear whether the higher kidney concentration of nickel was due to in-stream nickel concentrations or another factor.

While Naidoo et al. did not provide a table of in-stream metals concentrations, a graphical representation of metals concentrations (Figure 2, copied below) indicates that nickel concentrations were generally similar to the range of concentrations (12 and 40 μg/L, depending on the in-stream hardness concentration) allowed under the site-specific criterion adopted by Illinois with higher concentrations found at the sludge tank and downstream locations of one river site. Additionally, while the studies conducted by Ferrante and Mansour did not quantify the concentrations of nickel at their sites, in-stream nickel concentrations resulting from the types of contamination occurring at the sites investigated by Ferrante and Mansour (industrial discharges, agricultural runoff, and improperly treated organic and inorganic wastes) would be

[1] Ferrante et al. (2018) reported tissue concentrations as mg/kg wet weight. To better compare the reported tissue concentrations with the levels expected to produce adverse effects, EPA converted the results to mg/kg dry weight using the 3.3x conversion factor reported for rates by Wimmer et al. (1985).

expected to be at least as high as the in-stream nickel concentrations allowed under the site-specific criterion adopted by Illinois. As discussed above, the reported tissue concentrations of nickel in bats in each of these studies were all generally much less than the thresholds for adverse effects identified by Eisler (1998). Therefore, EPA concludes that, while it is possible that insectivorous bats exposed to elevated nickel concentrations may bioaccumulate more nickel than those inhabiting more pristine environments, nickel present in wastewater effluent discharged by the Sanitary District of Decatur is very unlikely to result in tissue concentrations that produce deleterious effects in the Indiana bat or northern long-eared bat.

Therefore, EPA concludes that approval of the site-specific chronic nickel criterion for a portion of the Sangamon River **may affect, but is not likely to adversely affect,** the Indiana bat or the northern long-eared bat.

V. Conclusion

Because IEPA's site-specific nickel criterion will not affect bat habitat; protects aquatic life, including emergent aquatic insects; the Indiana bat and northern long-eared bat do not prey heavily upon aquatic insects, and; EPA's analysis of the primary scientific literature indicates that bioaccumulative effects are unlikely, EPA concludes that approval of this site-specific nickel criterion **may affect, but is not likely to adversely affect**, the Indiana bat or the northern long-eared bat. A "not likely to adversely affect" determination requires consultation under Section 7 of the ESA. Therefore, EPA requests FWS concurrence with the approval of the site-specific criterion for a portion of the Sangamon River.

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